

Baleen Whale Calls and Seasonal Ocean Ambient Noise

John A. Hildebrand
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 932093-0205
phone: (858) 534-4069 fax: (858) 534-6849 e-mail: jhildebrand@ucsd.edu

Mark A. McDonald
2535 Sky view Lane
Laramie, WY 82070
phone/fax: (307) 742-0753 e-mail: mmcdon@worldnet.att.net

Bruce M. Howe
Applied Physics Laboratory
University of Washington
Seattle, WA 98105-6698
phone: (206) 543-9141 e-mail: howe@apl.washington.edu

Award Number: N00014-00-1-0212
<http://www.whaleacoustics.com>

Thrust Category: Long-Range Propagation

LONG-TERM GOALS

The goal of this study is to quantify the ambient noise contributions and whale population densities for blue, fin, and humpback whale in the North Pacific. This study will contribute to understanding the seasonal distribution of two acoustically different fin whale populations, two acoustically different blue whale populations, and of humpback whales.

OBJECTIVES

An ocean ambient noise data set has been collected for more than five years in conjunction with the ATOC ocean acoustic tomography project. These data are spectra to 500 Hz in 1 Hz bands averaged over 170 seconds recorded at five minute intervals at each of 15 deep ocean hydrophones from 1994 to 2000. These data are unique because of the widely separated hydrophone locations, the unclassified status of the data, and the long duration of the data set.

Our objective is to analyze these five years of acoustic recordings to understand the whale contribution to ambient noise. While whales have long been known to be a contributor to ocean ambient noise, these data reveal the whale contribution to be far greater than generally understood. The study will contribute to the understanding of how often whale calls are masked by man-made noise such as shipping and to the performance evaluation of Navy sonar systems such as LFA. Information on whale distribution is relevant to the Navy whale distribution databases such as LMRIS (C. Burris,

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE SEP 2000		2. REPORT TYPE		3. DATES COVERED 00-00-2000 to 00-00-2000	
4. TITLE AND SUBTITLE Baleen Whale Calls and Seasonal Ocean Ambient Noise				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Scripps Institution of Oceanography,,University of California, San Diego,,La Jolla,,CA,932093				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

SPAWAR) which is designed to provide information on marine mammal distribution and seasonality to the fleet.

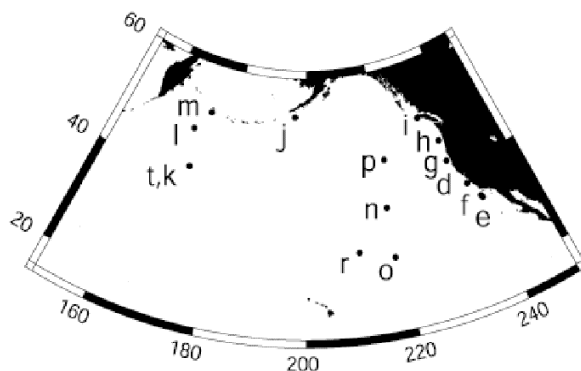


Figure 1. *The geographic locations of the 15 receivers for which ATOC noise spectral data are available.*

APPROACH

Whale calls are most commonly viewed with spectrograms utilizing an analyzing window shorter than the 170 seconds used to produce this data set. The 170 second averaging window obscures the precise location and water depth of the receivers, and provides a stable average for the high frequency spectra. Fin, blue and humpback whale calls all are suitable for analysis with this rather long averaging window. Call character is well known for at least five of the whale call types we propose to study and the relationships between whale presence and acoustic activities are to some degree understood. For example during humpback migration, only males are expected to call significantly. The study of geographic variation in the characteristic calls of blue whales, hence acoustic stocks of blue whales, is progressing rapidly in the north Pacific and will become possible worldwide as more hydrophones become available.

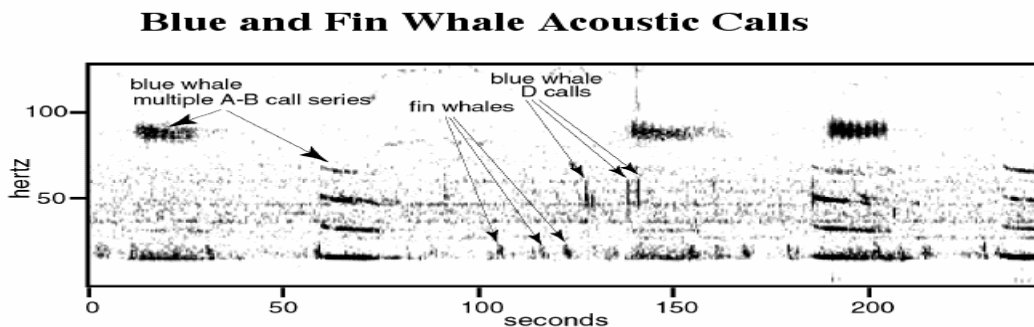


Figure 2. *Illustrates a spectrogram of calls from blue and fin whales in the eastern Pacific, recorded by a sonobuoy receiver.*

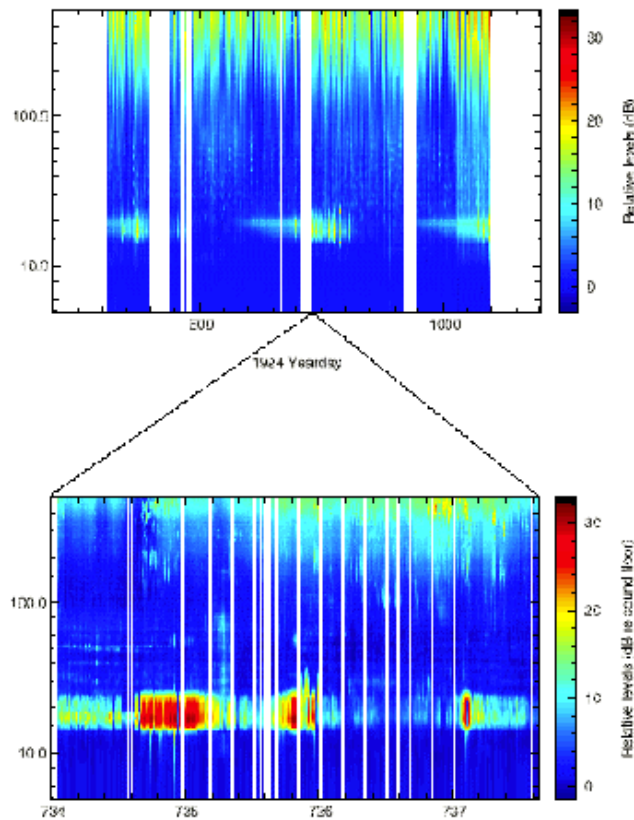


Figure 3. ATOC noise spectrogram measured at Receiver O. (a) Spectrogram for November 1994 – January 1997 displayed as one day averages. (b) Spectrogram for about three days showing a higher temporal resolution. The hot colors just below twenty hertz indicate the seasonal acoustic presence of blue and fin whales.

WORK COMPLETED

This project is being conducted as a collaboration between John Hildebrand (SIO-PI), Bruce Howe (UW-PI) and Mark McDonald. Specific responsibilities have been divided between data acquisition and initial processing by Howe, development of data processing tools for automated whale classification by McDonald, and ground truth of data processing by Hildebrand..

RESULTS

To date we have verified that the western Pacific blue whale calls have few harmonic components and two primary frequencies and thus are readily distinguished from the blue whales along the U.S. west coast in these noise spectra. We are currently working on estimating the seasonal acoustic population density for these two blue whale populations at each site. The following two spectrograms illustrate these call differences. The top spectrogram in figure 4 is from the central Pacific deepwater Receiver

O, showing only a low frequency (15-20 Hz) component to the call. The lower spectrogram is from the coastal California Receiver D, showing several higher frequency harmonics (e.g. 50 Hz).

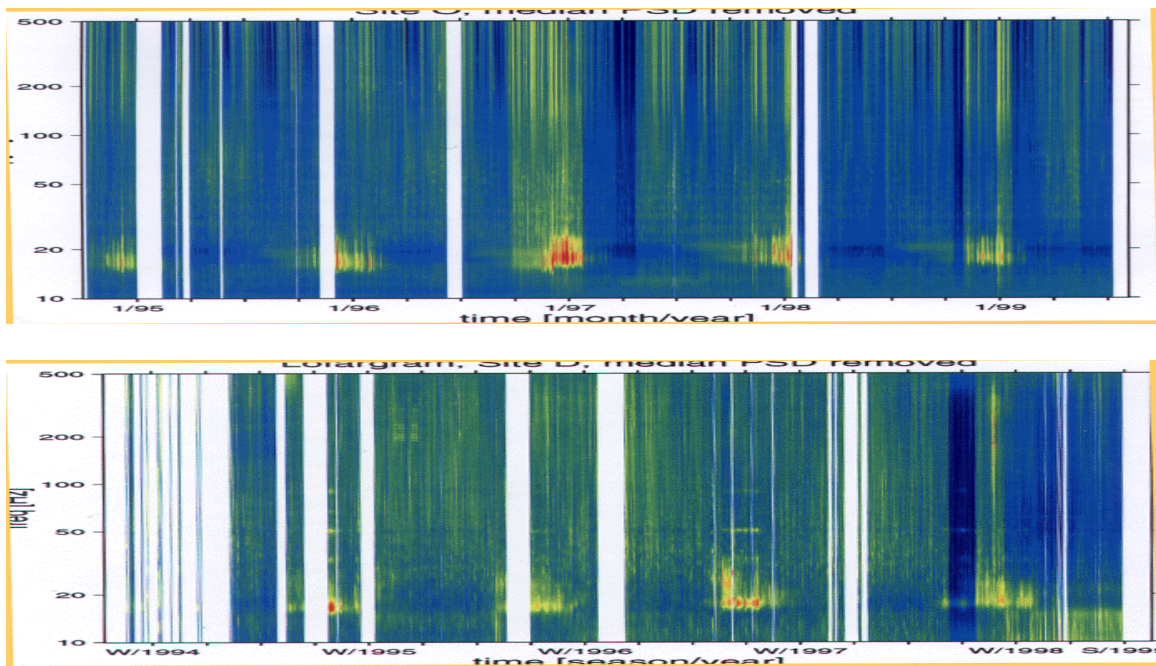


Figure 4. ATOC noise spectrogram from Receiver O (top) and Receiver D (bottom).

IMPACT/APPLICATIONS

These studies could have an impact on the means for determining whale population estimates, our understanding of the whale contribution to ambient noise in the ocean, and the potential interaction of man-made sounds and whales.